Dynamic Heterogeneity and the Behavior of Glass-Forming Materials at the Nanoscale

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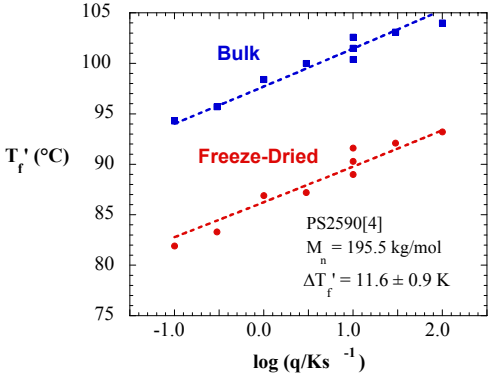
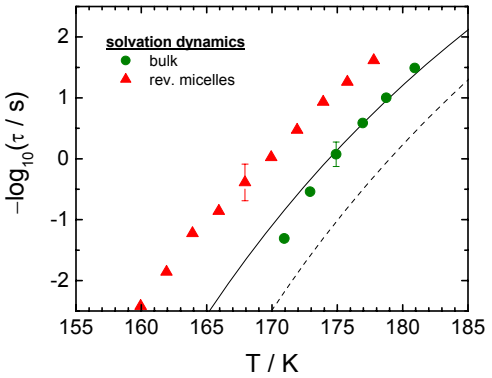
The impact of size and confinement on polymeric and low molecular weight glass formers is important for the function of materials in nano-applications, including in nanocomposites and nanoelectronics. In this research, we probe the molecular and thermodynamic properties of glass formers as a function of confinement size and type. Here we show the dramatic effect of molecular architecture on the depression of the glass transition temperature in freeze-dried polystyrene. We also show the impact of soft versus hard confinement on the relaxation time of propylene glycol.

1. Bernazzani et al., Polymer 44, 8025 (2003).

2. L.-M. Wang et al, Phys. Rev. Lett. 92 (2004) 095701.



Freeze drying imposes a type of confinement and dramatically reduces Tg in cyclic polystyrene.[1]



The "soft" constraint in 4.6 nm reverse miscelles shifts the propylene glycol response to shorter times, whereas the "hard" constraint in 10nm porous glass(dashed line) shifts the response to longer times.[2]

Education:

One undergraduate researcher, Neeraj Dani, four graduate students, Fang He, Stephen Hutcheson, Qian Qin, Wei Zheng, and one post-doctoral researcher, Justin Rajesh Rajian, are being trained through this grant. The students and post-doc involved in the project at TTU under the supervision of Profs. Simon, McKenna, and/or Quitevis, participate in a weekly NIRT meeting in which the goals of the project, progress, milestones, and relevant literature are discussed using a formal presentation by one member of the group as a vehicle to initiate the exchange of ideas.

Outreach:

Outreach has included presentations by the PIs on the findings of this project at various national and international meetings, including the American Physical Society, the Society of Plastics Engineers, and the "Times of Polymers" Conference in Italy. In addition, Prof. Richert gave a joint seminar in Chemistry and Chemical Engineering at TTU in the fall and Prof. McKenna gave a seminar in Chemistry at ASU in the spring. Other outreach activities have included helping two sixth-grade students with their science fair projects on sol-gel glasses.